culture of onions, generally procure their seed from London; but it is by no means improbable, that by care in saving the seed at home, as is done by some farmers with flax, it may be had as good as that which is imported, and at little or no expense.

S. T.

*For the Belfast Monthly Magazine.*

## OF BURNING MIRRORS.

*From Oznaham's Mathematical Recreations.*

THE properties of burning mirrors may be deduced from the following proposition, viz. "If a ray of light fall very near the axis of a concave spherical surface, and parallel to that axis, it will be reflected in such a manner, as to meet it at a distance from the mirror, nearly equal to half the radius." At that distance, the solar rays, which are sensibly parallel when they fall on a concave surface, will be there condensed, if not into one point, at least into a very small space, where they will produce a powerful heat, so much the stronger, as the breadth of the mirror is greater. For this reason the place where the rays meet is called the *focus*, or burning point.

The focus of a concave mirror, is not, however, a mere point: it has, on the contrary, a pretty sensible magnitude. Thus, for example, if a mirror be the portion of a sphere of six feet radius, and form an arc of thirty degrees, which gives a breadth of somewhat more than three feet, its focus ought to be about the fifty-sixth part of that size, or between seven and eight lines. The rays, therefore, which fall on a circle of three feet diameter, will, for the most part, be collected into a circle of a diameter fifty-six less, and which consequently is only the 3136th part of the space, or surface. It may hence be easily conceived what degree of heat such mirrors must produce, since the heat of boiling water is only *triple* that of the direct rays of the sun on a fine summer's day.

Attempts, however, have been made to construct mirrors, which collect all the rays of the sun into one point, and experiment has ascertained, that this may be effected by a well polished parabolic spheroid, and a much greater degree of heat be procured.

As the focus of a spherical mirror is at the distance of the fourth part of the diameter, or (as above) one half the radius, the impossibility of Archimedes being able with such a mirror, to burn the Roman ships, supposing their distance to have been only thirty paces, as Kircher says, he remarked, when at Syracuse, may be easily conceived; for it would have been necessary, that the sphere of which his mirror was a portion, should have had a radius of sixty paces, and to construct such a sphere would have been impossible. A parabolic mirror would be attended with the same inconvenience.

Besides, the Romans must have been wonderfully condescending, to suffer themselves to be burnt so near, without deranging the machine. If the mathematician of Syracuse therefore did burn the ships of the Romans by means of the solar rays, he must have succeeded in some other way; and such a way has been rendered probable by an experiment conducted by Buffon, which any one may try for himself by following these directions.

Arrange a great number of plane mirrors, each about six or eight inches square, in such a manner, that the solar rays, reflected from them may be united in one focus.

Anthemius of Tralles, the architect and engineer, who lived under Justinian, is the first, who according to the account of Vitellio conceived the idea of employing plane mirrors for burning: but it is to Buffon we are indebted for a proof of its being practicable. In the year 1747, he caused to be constructed a machine consisting of three hundred and sixty plane mirrors, each eight inches square, and all moveable on hinges, in such a manner, that they could be made to assume any position at pleasure. By means of this machine he was able *to burn wood at the distance of two hundred feet.*

That the ancients made use of burning glasses is evident, from a passage in a play of Aristophanes, called the Clouds, where Strepsiades tells Socrates, that he had found out an excellent method to defeat his creditors, if they

should bring an action against him. His contrivance was, that he would get from the jewellers a certain transparent stone, which was used for kindling fire, and then, standing at a distance, he would hold it to the sun, and melt down the wax, on which the action was written.

The astonishing philosophico-military exploit of Archimedes may deserve some farther notice: it has been recorded by many ancient writers. The account of Tzetzes is so particular, that it suggested to Father Kircher the specific method, by which Archimedes probably effected his purpose. "Archimedes," says that author, "set fire to the fleet of Marcellus by a burning glass, composed of small square mirrors, moving every way upon hinges; and which, when placed in the sun's rays, reflected them on the Roman fleet, so as to reduce it to ashes, at the distance of a bow shot."

This account gained additional probability by the effect Zonaras ascribes to the burning mirror of Proclus, by which he affirms, that the fleet of Vitellius, when besieging Byzantium, now Constantinople, was utterly consumed. But, perhaps, no historical testimony could have gained belief to such extraordinary facts, if similar ones had not been seen in modern times. In the Memoirs of the French Academy of Sciences for 1726, we read of a plane mirror of twelve inches square, reflecting the sun's rays to a concave mirror, sixteen inches in diameter, in the focus of which bodies were burnt at the distance of six hundred paces.

The ancients are supposed to have made use of concave mirrors to rekindle the vestal fires. Plutarch, in his life of Numa, says, that the instruments used for this purpose were dishes placed opposite to the sun, and the combustible matter placed in the centre, by which it is probable, he meant the focus, conceiving that to be at the centre of the mirror's concavity.

We cannot here omit to mention some mirrors celebrated on account of their size, and the effects they produced; one of them was the work of Settala, a canon of Milan; it was parabolic, and inflamed wood at the distance of fifteen or sixteen paces.

Villette, an artist and optician of Lyons, constructed three about 1670, one of which was purchased by Tavernier, and presented to the king of Persia; the second was purchased by the king of Denmark, and the third by the king of France. The one last mentioned was thirty inches in diameter, and of about three feet focus. The rays of the sun were collected by it into the space of about half-a-guinea. It immediately set fire to the greenest wood, it fused silver and copper in a few seconds, and in one minute vitrified brick, flint, and other vitrifiable substances.

These mirrors were, however, inferior to that constructed by Baron Tchirnhausen, about 1687. It consisted of a metal plate twice as thick as the blade of a common knife; it was about five feet three inches in breadth, and its focal distance, three feet and a half; it produced the following effects:

Wood exposed to its focus, immediately took fire, and the most violent wind was not able to extinguish it.

Water contained in an earthen vessel, was instantly thrown into a state of ebullition, so that eggs were boiled in it in a moment, and soon after the whole water was evaporated.

Copper and silver passed into fusion in a few minutes, and slate was transformed into a kind of black glass, which when laid hold of with a pair of pincers could be drawn out into filaments.

Brick was fused into a kind of yellow glass; pumice stone and fragments of crucibles, which had withstood the most violent furnaces, were also vitrified. This mirror afterwards came into the possession of the King of France, and was kept in the Jardin du Roi, exposed to the injuries of the air, which in a great measure destroyed its polish. But metal is not the only substance of which burning mirrors have been made. We are told by Wolf that an artist of Dresden, named Gaertner, constructed one in imitation of Tchirnhausen's, composed of wood only, which produced effects equally astonishing; but we are left in the dark, as to the manner of giving the wood the necessary polish.

J. Zahn mentions something more singular than this, of an engineer of Vienna, in 1699, who made a mirror of paste-board, covered on the inside with straw cemented to it, which was so powerful as to fuse all metals.

Concave mirrors of a considerable diameter, and which produce the same effect as the preceding, may be now procured at much less expence; and for this we are indebted to M. de Bernieres. The concave mirrors he constructed were round pieces of glass bent into a spherical form; concave on the one side, the convex on the other, and silvered on the convex side. He constructed one for the King of France, three feet and a half in diameter, which was presented to his majesty in 1757. Forged iron exposed to its focus was fused in two seconds; silver ran in such a manner, that when dropped into water it extended itself in the form of a spider's web, &c.

Lenticular glasses have been made to produce similar effects. Tchirnhausen constructed one of this kind of very large dimensions. Being near the Saxon glass manufactories, he was enabled about 1696 to procure plates of glass so as to form lenses several feet in diameter. One of them, of this size, inflamed combustible substances at the distance of twelve feet. At that distance its focus was about one inch and a half, in diameter. But when it was required to make it produce its greatest effects, the focus was diminished by means of a second lens, placed parallel to the former, and at the distance of four feet.

In this manner the diameter of the focus was reduced to eight lines, and it then fused metals, vitrified flint, tiles, and in short, produced the same effects as the burning mirrors already spoken of.

For the means of obtaining at a less expence glasses capable of producing the same effects, we are again indebted to M. de Bernieres. His invention is, to bend two circular plates of glass into a spherical form, and being then applied to each other, the interval is filled with distilled water, or spirits of wine. These glasses, or rather, water lenses have their focus a little farther distant, and *ceteris paribus*, ought to produce a somewhat less effect? but the thinness of the glass and transparency of the water occasion less loss in the rays, than in a lens of several inches in thickness, and it is far easier to procure a lens of this construction, than solid ones like that of Tchirnhausen. M. de Trudaine, some years ago prevailed on M. de Bernieres, to construct one of those water lenses for him, four feet in diameter. The heat produced by this instrument is much superior to that of all the burning glasses and mirrors hitherto known, and even exceeds that of furnaces.

Such are Montucla's account and observations, as Dr. Hutton has translated him. These inventions and experiments have been made a great many years, and when it is considered how desirable it is on many occasions to procure a great melting or burning power, it may justly seem surprising, that they have not been placed beyond the bounds of mere gratification of curiosity, and made subservient to some useful purposes. Chemists might surely find the burning glass, made to form such a focus as might be required, useful in fusing specimens of those metals, which are most difficult to be fused; and we need make very little doubt, but that when skill in forming glass to required dimensions and facility in the use of them were attained, many of the disagreeable and laborious operations of the furnace might be laid aside, and much time also gained.

---

*To the Editor of the Belfast Magazine.*

SIR,

IT is universally allowed, that to read and speak well, are very pleasing and valuable accomplishments. To professional men who have to deliver discourses or pronounce speeches in public, they are of the greatest consequence, as a good style of elocution is now generally expected from them, and considerably contributes to their success in life. But to such persons the advantages of elocution are by no means confined. Occasions perpetually occur, in which they are perceived and felt by persons in every condition of life. To every family circle, a few good readers are a valuable acquisition; and furnish it with the means of promoting a taste for instructive reading, and the diffusion of useful knowledge. What might other-